THE NEGATIVE IMPACT OF VARIABLE RENEWABLE ENERGY (VRE) TO THE POWER SYSTEM STABILITY – THE RENAISSANCE OF SYNCHRONOUS CONDENSERS

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Abstract

Due to the increasing share of wind and solar generation, battery energy storage systems and direct current network lines interconnected via inverters with transmission and sub-transmission systems the power system stability decreases. This paper explains what the impacts are and shows possible ways to mitigate them.

Since the 1980's greenfield installations of Synchronous Condensers disappeared and were replaced by SVCs (static VAR compensation) and later STATCOMs (static synchronous compensator), due to the cost competitiveness of those technologies. System strength and system inertia, were not in a focus, as it was available in abundance due to the high share of synchronous generators connected to the grid.

Due to the increasing share of wind and solar generation, battery energy storage systems and direct current network lines interconnected via inverters (IBRs, inverter-based re-sources) with transmission and sub-transmission systems the situation changed significa-ntly. High penetration of IBRs results in lower stability of the electric power system, namely reduced frequency stability, reduced voltage stability, reduced rotor angle stability, reduced resonance stability and reduced converter driven stability .

Several transmission systems operators reacted already to the fact, that compensation devices such as SVCs and STATCOMs support only regarding the voltage stability, and not regarding other stabilities issues. The energy transitions conditions that the amount of IBRs (PV and Wind generation) will replace thermal power plants (e.g. coal, gas). This causes that the short circuit power and inertia is reduced, leading to lower system strength. One the one hand, wider area undamped voltage and power oscillations, generator fault ride-through degradation, mal-operation or failure of protection equipment, prolonged voltage recovery after a disturbance (FIDVR), larger voltage step changes after switching capacitors, increa-sed harmonic distortion, deeper voltage sags and higher voltage transients. On the one hand, higher frequency instability due to higher frequency gradients i.e. RoCoF , deteriorati-on of fault detection. Both result in limited hosting capacity of the power system to further integrate renewable wind and photovoltaic generation.

The proposed presentation:

- explains what the contributions and limits of Synchronous Condenser Systems are in terms of short circuit contribution in MVA (increasing system strength), inertia in MWs and reactive power compensation in MVAr.
- highlights the differences, pros and cons, between the 2 different Synchronous Con-denser designs (salient pole design and cylindrical rotor design)
- showcases of recent Synchronous Condenser projects of ANDRITZ

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